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Modelling Picrite-Rhyolite Magmatism at Spitzkoppe, Western Namibia, using alphaMELTS 2 and the Magma Chamber Simulator

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Modelling the early Cretaceous tholeiitic suite of picrite-to-rhyolite dykes from the Spitzkoppe region of Namibia (Thompson et al., 2007), was the original motivation for adding isenthalpic assimilation and fractional crystallization to the alphaMELTS software (then called *Adiabat_1ph*; Smith & Asimow, 2005). For most measured major oxides and trace elements (Al₂O₃ being an exception), observed data from the dyke swarm fell between trends modelled with (p)MELTS for (a) closed-system fractional crystallization, dominated by conductive heat loss, and (b) heat-balanced assimilation and fractional crystallization, with local granitic crust as the contaminant. alphaMELTS 2 is a complete rewrite of the alphaMELTS software built on the latest rhyolite-MELTS / pMELTS code, including an improved algorithm for detection of phase saturation (Ghiorso, 2014). Routines for assimilation, reverse fractionation, and fitting the liquid line of descent (LLD) for fractional crystallization have recently been added to alphaMELTS 2, and are used here to revisit the evolution of Spitzkoppe dykes. A MATLAB/Python version of the software can be automated to map the effects of oxygen fugacity and volatile content on modelled LLDs and has the flexibility to explore the model space between the two end-member scenarios.

Unlike the original MELTS liquid calibration (Ghiorso & Sack, 1995), the rhyolite-MELTS and H₂O-CO₂ mixed fluid model (Gualda et al. 2012; Ghiorso & Gualda 2015) successfully predicts the major element compositions of the more evolved Spitzkoppe dykes. Fractional crystallization models (without assimilation) that match the trend in Al₂O₃ slightly overestimate total Fe as Fe₂O₃ at low MgO, and vice versa, but the overall fit to the major elements is significantly improved compared to Thompson et al. (2007). By alternating heat-balanced assimilation steps and closed-system (except for oxygen) fractionation a family of thermodynamic models is generated that simultaneously explains major and trace element trends, and isotopic signatures of the Spitzkoppe suite. The alphaMELTS 2 models are compared to ones constructed using the Magma Chamber Simulator (Bohrson et al. 2014) and will be included in the Database of AlphaMELTS@CIT Examples (DACITE; part of an upcoming alphaMELTS 2 website: alphamelts.caltech.edu).